

National Aeronautics and Space Administration

Soil Moisture
Active Passive
Mission
SMAP

Soil Moisture Active/Passive (SMAP) Radiometer Subband Calibration and Calibration Drift

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Subband Calibration Approaches

- Approach 1
 - All of the 16 subbands' TAs are compared to expected TA
 - Same as full band calibration
- Approach 2
 - Subbands TAs are compared to full band TA
 - Calibrate Tnd and Tref offset of each subband
 - Relation between subband & fullband TAs

$$T_{A,fb} = aT_{A,sb} + b$$

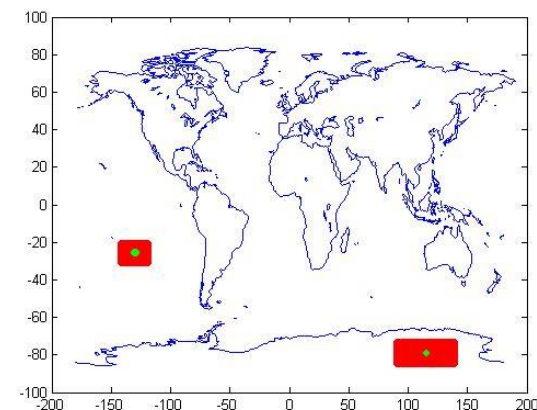
Adjusted subband TA: $\hat{T}_{A,sb} = \hat{a}T_{A,sb} + \hat{b}$

- Subband Tnd and Tref will be adjusted

$$T'_{nd,sb} = \hat{a}T_{nd,sb}$$

$$T'_{ref,sb} = \hat{a}T_{ref,sb} + \hat{b}$$

$$= T_{ref,sb} + (\hat{a} - 1)T_{ref,sb} + \hat{b}$$





Data Selection Criteria

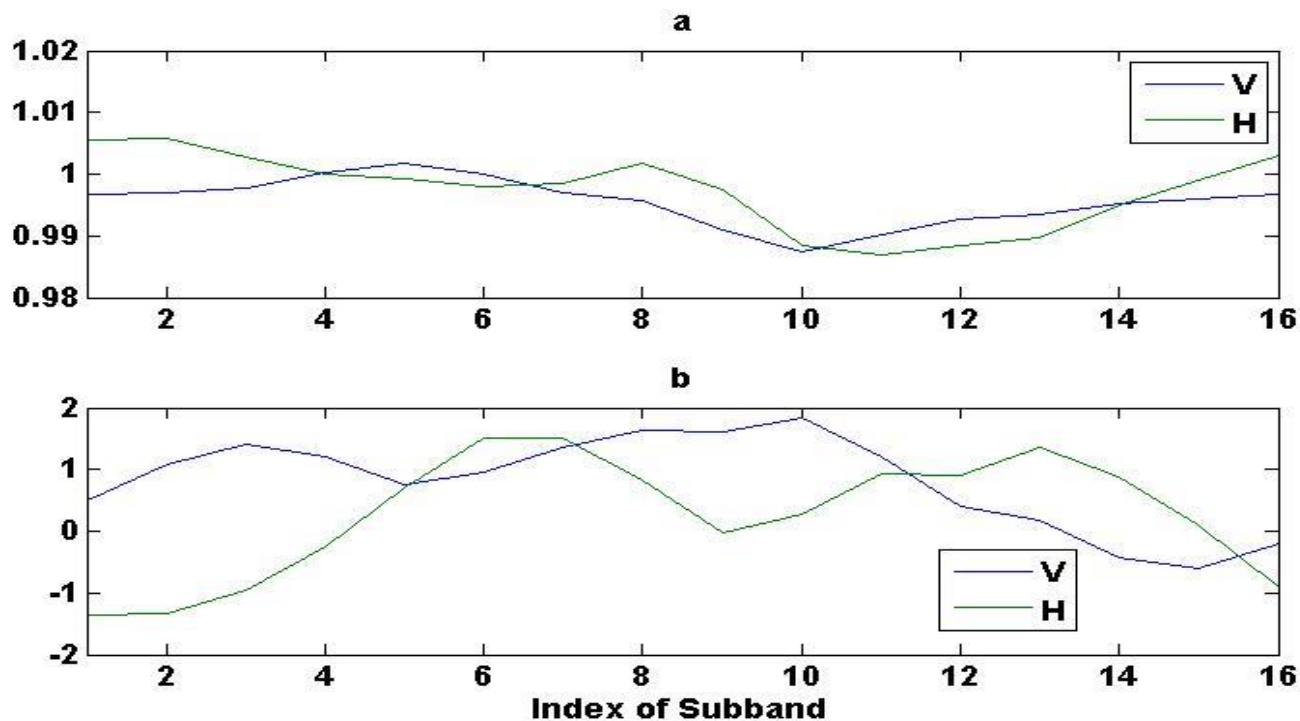


- Data selection criteria
 - L1B quality flag bit 0 = 0
 - ta_filtered = ta
 - Reflected antenna boresight away from galactic plane
- Training dataset
 - April 01 ~ 03, 2015
 - RAD high-rate data mode
- Test dataset
 - April 04 ~ May 05, 2015



Subband Adjust Coefficient

- Training dataset: ~3 days (April 1 ~ 3, 2015)
- Half data for ocean, half data for land/ice





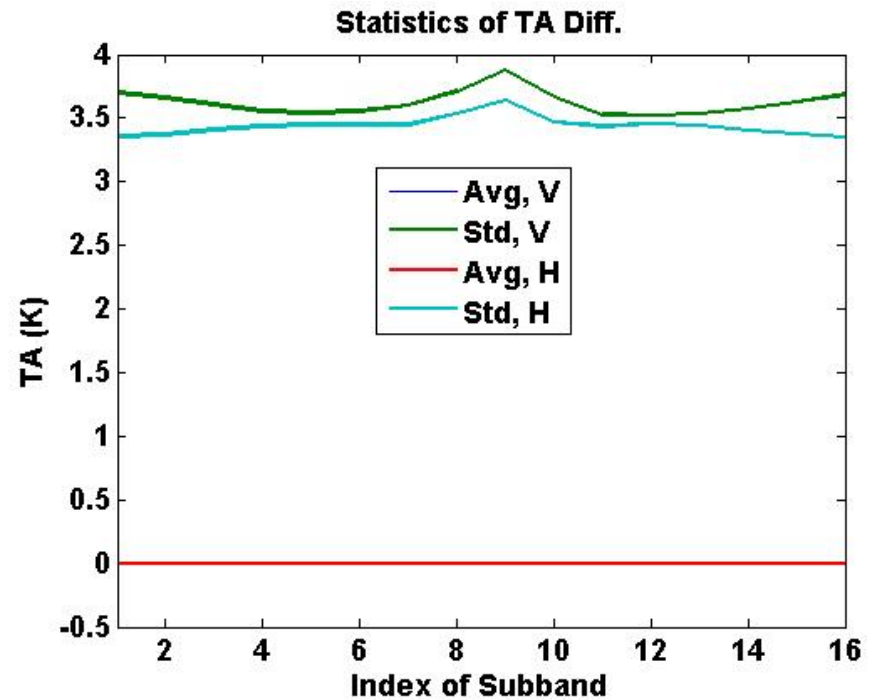
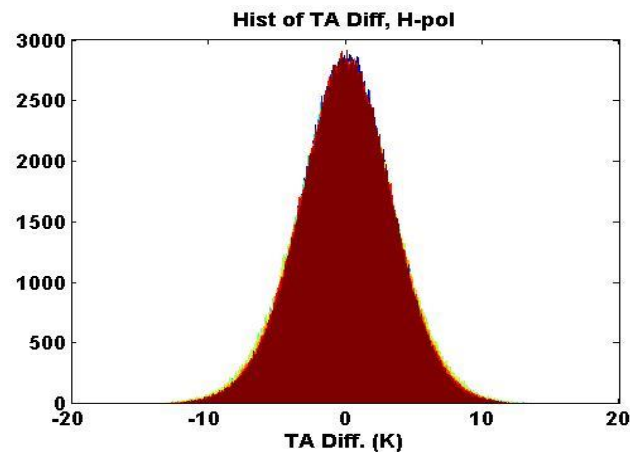
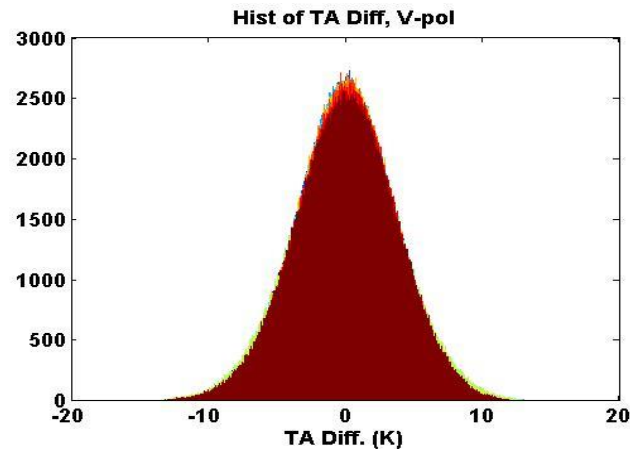
Performance

(training dataset)



- Subband TA difference

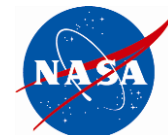
$$\delta \hat{T}_{A, sb} = \hat{T}_{A, sb} - T_{A, fb}$$





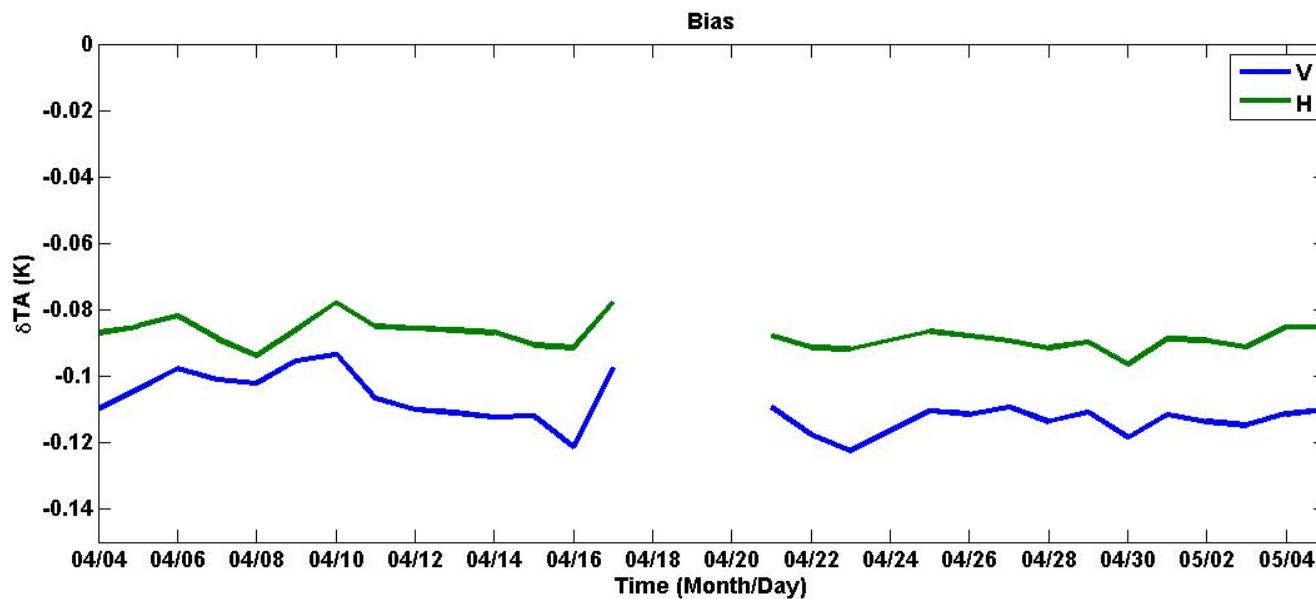
Performance

(test dataset)



- Initial result for the test dataset
 - Low rate mode data
 - Daily averaged

$$\hat{T}_{A,fb} = \sum_{i=1}^{16} \hat{T}_{A,sb,i}$$
$$\delta \hat{T}_{A,fb} = \hat{T}_{A,fb} - T_{A,fb}$$

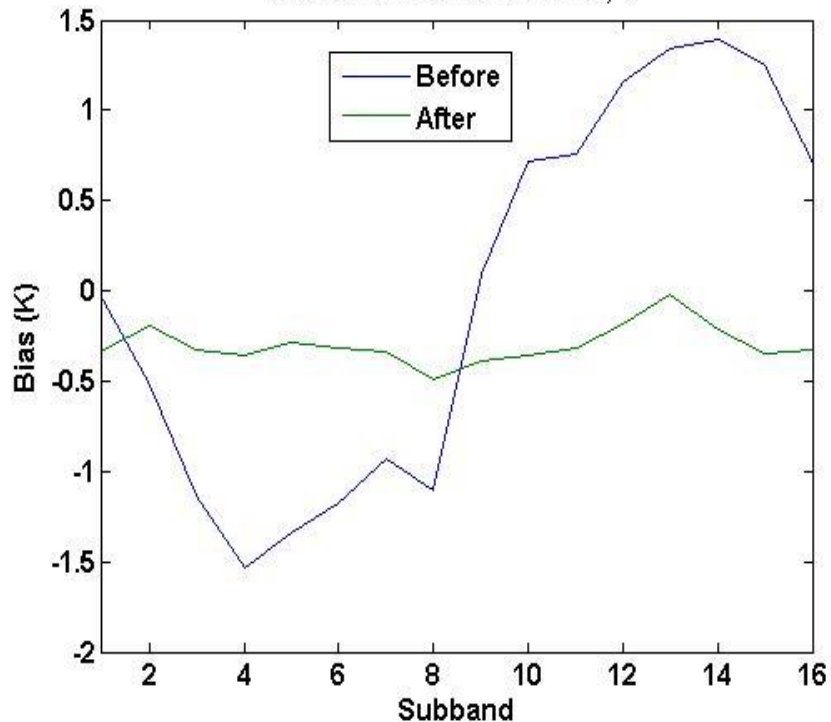




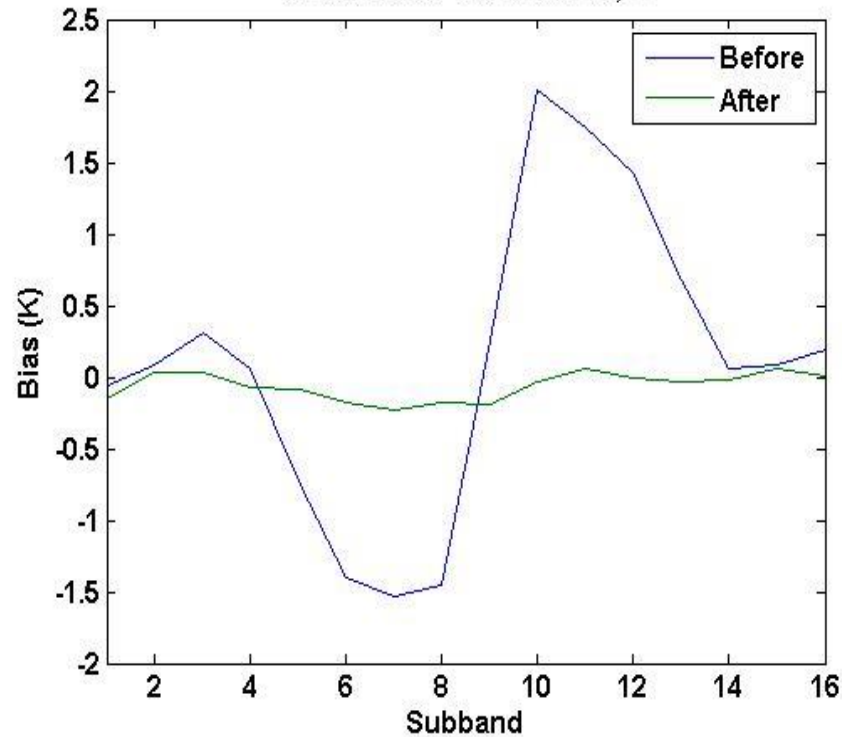
Performance (cont.)

- Tested using one half orbit
- Subband cal coefficients (Tnd, Tref offset) updated

Subband TA - Fullband TA, V



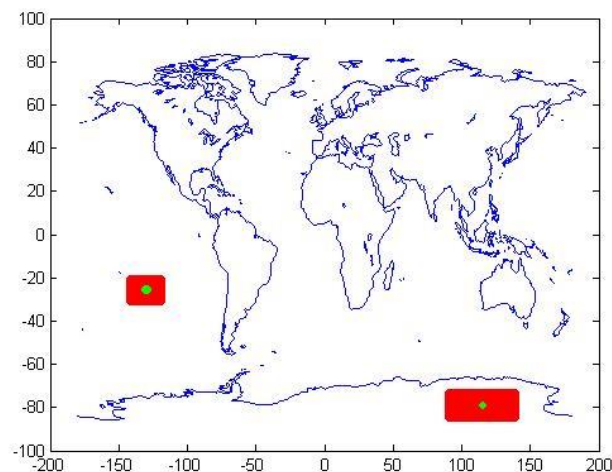
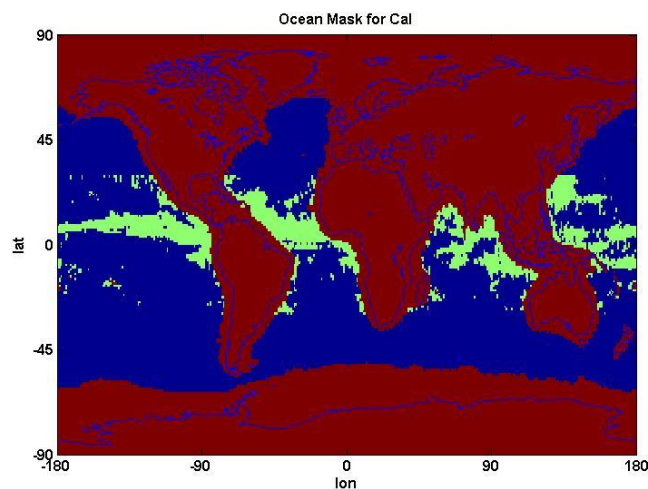
Subband TA - Fullband TA, H





Drift Monitor Approach

- Compare calibrated antenna temperature to modeled antenna temperature over desired calibration targets
- Selected Calibration Target
 - 1) whole ocean exclude heavy rain zone
 - 2) Selected ocean calibration region
 - for backup
 - 3) Dome-C
 - work in progress
- Daily averaged TA difference monitor the calibration drift





TA Forward Model

- Generate expected antenna temperature
- Earth surface TB models
 - Earth surface is classified as Land, Ocean and Ice
 - Ocean includes sea ice.
 - Land TB from Nature Run v03
 - Ocean TB model: L-band GMF ^[1]
 - Ice dielectric constant model: the Ulaby et al. model ^[2]
 - used by Aquarius
- Atmospheric RT model
 - T_{up} , T_{down} , Loss are functions of the Earth's surface elevation
- Faraday rotation model
 - Use IGS TEC to compute Faraday rotation angle
 - IGS TEC is scaled by factor 0.75
- APC
 - Inversion of L1B APC correction in general

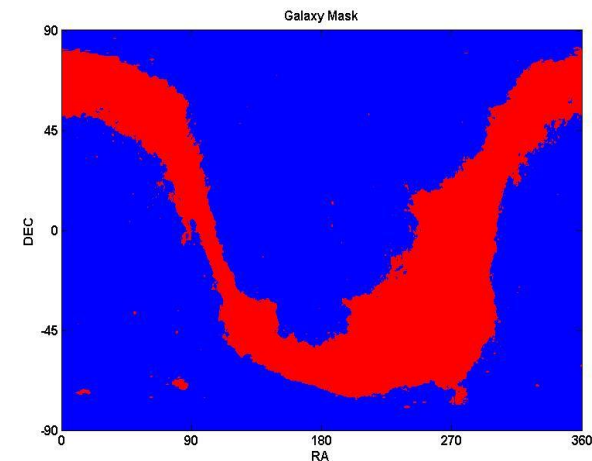
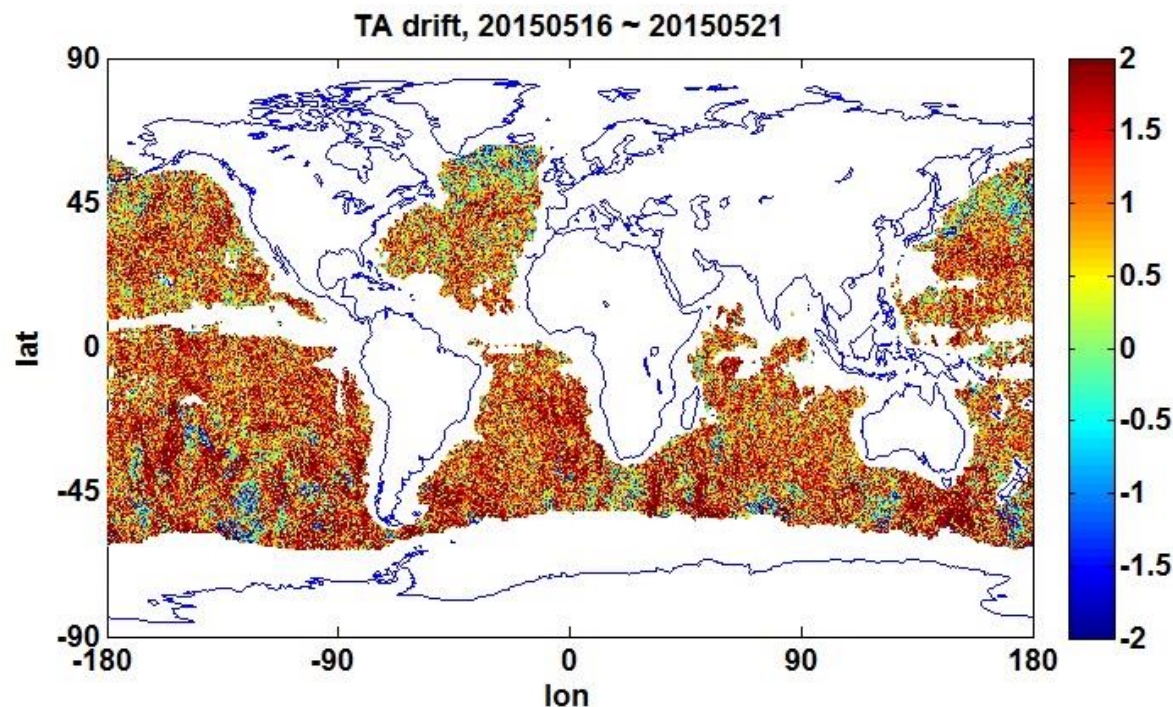
[1] S.H. Yueh et al, "L-Band Passive and Active Microwave Geophysical Model Functions of Ocean Surface Winds and Applications to Aquarius Retrieval," *Geoscience and Remote Sensing, IEEE Transactions on*, vol.51, no.9, pp.4619,4632, Sept. 2013. doi: 10.1109/TGRS.2013.2266915

[2] F. T. Ulaby et al, *Microwave Remote Sensing—Active and Passive*, vol. 3, *Volume Scattering and Emission Theory, Advanced Systems and Applications*. Boston, MA: Artech House, 1986.



Data Selection Criteria

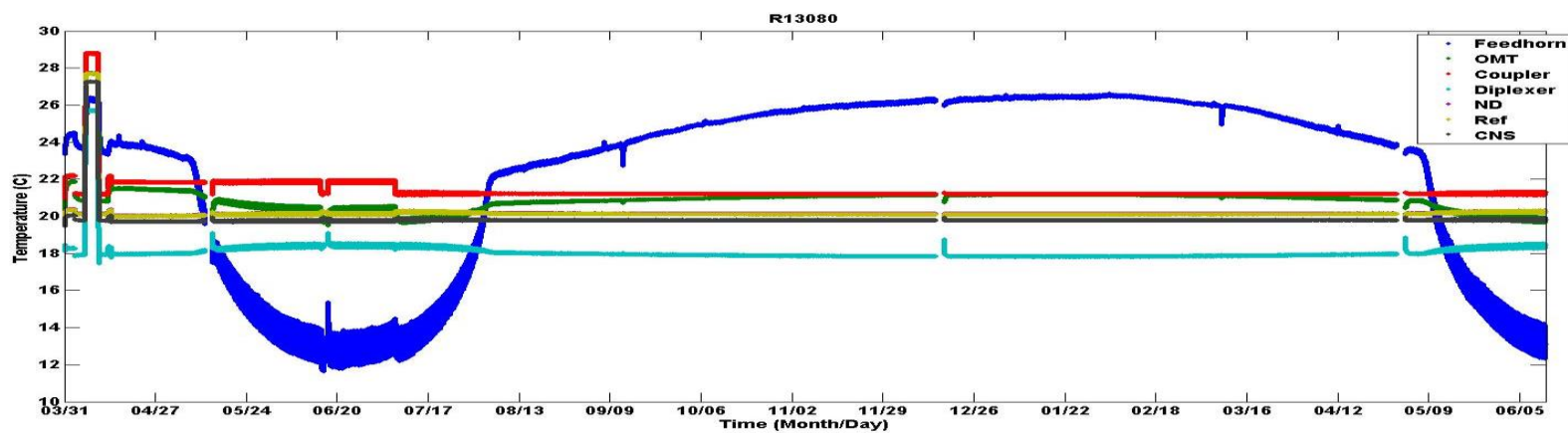
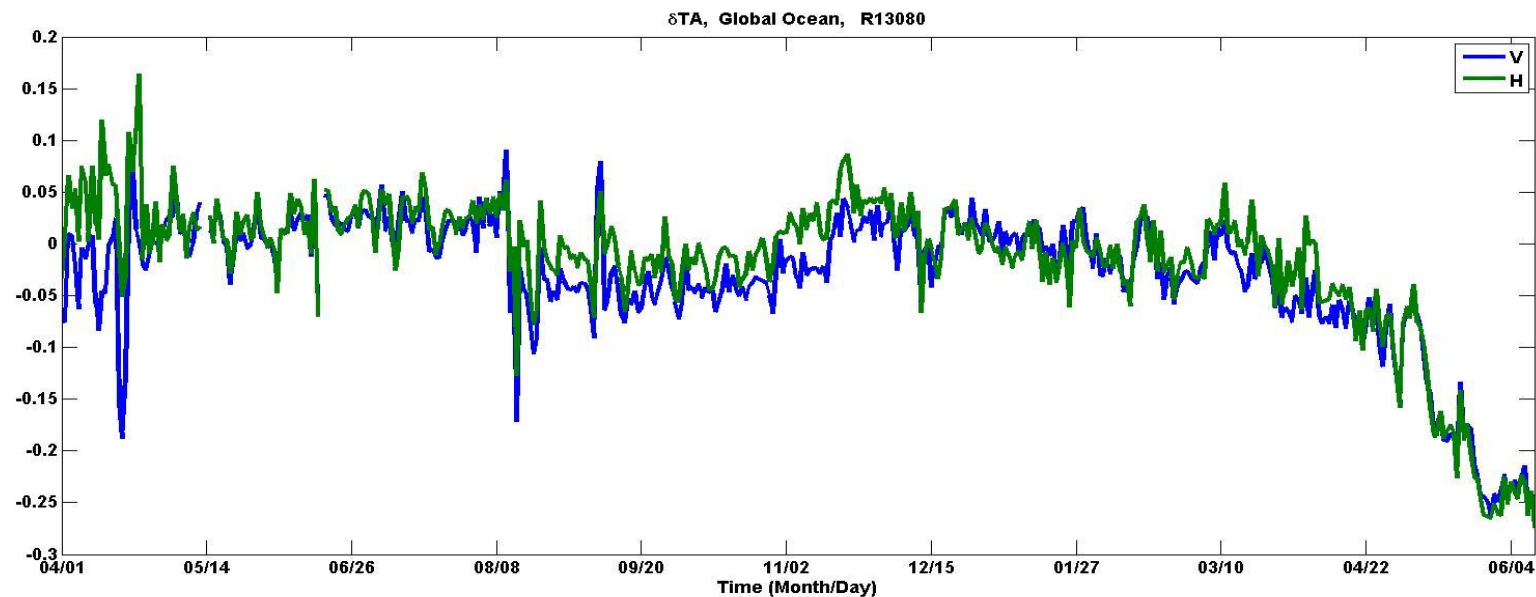
- L1B data quality flag bit 0 = 0
 - brightness temperature measurement has acceptable quality
- Reflected antenna boresight away from galactic plane
- TA is within reasonable range
 - L1B TA
 - expected TA





Current Performance

- Global ocean target





Conclusion



- Two subband calibration approaches are tested.
 - Using fullband to calibration subbands
 - 0.1 K bias exists for low-rate mode data
 - Using expected TA to calibrate both fullband and subbands
 - ~0.05 K bias switching from low-rate mode to high-rate mode
 - Used for the main method to calibrate approach
- Radiometer drift satisfy requirement
 - Less than 0.1 K / month